

## SECTION VIII

**Area of Review**

The Area of Review is the area within which the owner or operator of a Class I injection well must identify all artificial penetrations that penetrate the confining zone and/or injection zone and determine whether they have been completed or plugged so that they do not provide conduits for fluid movement. Artificial penetrations constitute a possible threat to human health or the environment because of their potential for conveying injected effluent and formation fluid out of the injection zone and/or conveying fluid (injected effluent or formation brine) into an underground source of drinking water (USDW) (non-endangerment standard).

Under the Texas Administrative Code (TAC) §331.42(b)(1) standard, the Area of Review for a Class I injection well corresponds to the area within a fixed 2.5-mile radius of the injection well or based on the calculated "cone of influence" of the injection well, whichever is greater. The "cone of influence" is defined as "...the potentiometric surface area around the injection well within which increased injection zone pressures caused by injection of effluent would be sufficient to drive fluids into a USDW or freshwater aquifer" (TAC §331.2). For the TexCom Gulf Disposal, LLC facility commercial permit application the Area of Review is a fixed 2.5-mile radius.

Five hundred and five artificial penetrations were identified in the Area of Review for the TexCom facility (Table VIII-1). Each of these wells were evaluated for non-endangerment. Due to the age of most of the wells and the lack of adequate records on a significant number of the wells, TexCom treated most of the wells as being unplugged and evaluated them as such. All of the wells were completed in the Upper portion of the Cockfield Formation and this provides significant vertical separation between the perforated injection zone and the base of the wells.

Based on projected, annualized, maximum modeled injection rates at the TexCom facility for a 30-year facility life, the modeling projection determined that interformational fluid flow will not occur in these boreholes, even under very conservative conditions. Based on the results of the evaluation, no corrective action is necessary for any of the wells in the Area of Review of the TexCom facility under the conditions requested in this Permit Application. **Natural borehole closure** has not been quantified, **but would add significantly to the safety of these artificial penetrations.**

## **VIII.A Area of Review Map**

A base map showing the permit application identification number and location of the artificial penetrations in the 2.5-mile radius Area of Review is included as **Figure VIII-1**. This map was prepared on a USGS Topographic Quadrangle base and shows the location of the facility, the injection wells, surface bodies of water, springs, mines (surface and subsurface), quarries, and other pertinent surface features (including residences and roads). No surface faults are known to occur in the Area of Review.

## **VIII.B Artificial Penetrations in the Area of Review**

A thorough record search was conducted during preparation of this Permit Application by the applicant in accordance with 30 TAC §331.121(a)(2)(A) to locate all artificial penetrations that lie within the 2.5-mile radius Area of Review. A total of 505 artificial penetrations were identified. The following sections describe the protocol used to conduct the artificial penetration search.

### **VIII.B.1 Artificial Penetration Protocol**

As used in current regulations, the Area of Review pertains to the area within which the owner or operator of Class I Injection wells must identify all artificial penetrations that penetrate the site-specific confining and/or injection zone. These artificial penetrations constitute a possible threat to Underground Sources of Drinking Water (USDW) because of their potential for conveying fluid from an injection reservoir to the overlying USDW (non-endangerment standard). The Area of Review for the non-endangerment standard is defined as a fixed 2.5-mile radius around the injection well unless the calculated cone of influence of the injection well warrants a larger Area of Review ( TAC §331.42(b)(1)). State regulations require, in the Area of Review phase of the permitting process, identification and evaluation of artificial penetrations followed by appropriate action to mitigate any potentially threatening situation. Following is an outline of the steps that were taken to identify and evaluate an artificial penetration in the Area of Review pursuant to permit requirements.

### **VIII.B.2 Well Identification**

#### **VIII.B.2.1 File Search and Research**

The well record filing system of the Texas Railroad Commission is cumbersome due to changes in filing procedures implemented through the years. The enormous amount of information contained within the system has often been reorganized when directors of the Texas Railroad Commission have changed.

**VIII.B.2.1.3 Microfilm Records**

All records filed with the Texas Railroad Commission prior to 1973 are found on microfiche and microfilm. Records in some Texas Railroad Commission districts are filmed through 1980. These microfiche and microfilm records are organized in several different systems: such as operator and lease name, or district, field, and operator name, or district, field, and lease number. Within the aforementioned filing systems, there are a large number of exceptions to the filing procedures which create additional filing systems within these categories. The various types of standard film sets are as follows:

**Unit Cards**

These are microfiche records for wells which had records filed with the Texas Railroad Commission prior to 1962. These units are filed sequentially by an operator number assigned by the Texas Railroad Commission when the operator filed the required organization report with the agency. The operator number can be referenced in either the county book or the county microfiche. A county book is maintained for each county within the state. Within the county book, the information is organized alphabetically by lease name which cross references to the operator name and corresponding operator number. The county microfiche are a recent addition to the Texas Railroad Commission filing system. The agency took the county books and reorganized the leases into alphabetical order and microfilmed the information. Although the county books are not organized as neatly as the county microfiche, they are the original system and are more accurate due to unintentional omissions made when reorganizing the listings.

Operator numbers can also be obtained from old copies of organization ledgers maintained by the Texas Railroad Commission. These ledgers are in five separate sets which correspond to various time periods from the 1920's to the 1960's. They list only operator names, addresses, and numbers assigned by the agency, and are used as a last resort, since they do not indicate lease names and often list multiple operators with the same name.

Once the operator name is matched to a lease name and an operator number is given, the unit card, if available, is pulled. The lease names are filed alphabetically within each operator number. Since there are exceptions to the filing system, if the desired information is not available or only partially available on the unit card, then the researcher must proceed to the next set of microfilm.

**Well Records-Folders Rolls**

Duplicate copies of unit cards, which sometimes contain information that was not included in the initial filming of the unit cards, are referenced on the folder rolls. The folder rolls are organized by operator number and folder number which appear on the unit card jacket. In addition, some folder rolls do not have a folder number given, but only an operator number. These rolls are called "add-on rolls" and also contain records not included in the initial filming of the unit cards.

**Well Records-Runs 20 to 30 and A to I**

These rolls are organized by operator number and by specific periods of years. They encompass the time period from 1945 to 1960 and commonly have three to five rolls for a specific year and operator number. When information is not available on the unit cards, these are the next set of film to be researched for records.

**Well Records-Major Runs**

This is a special set of film that contains only information on records filed by major operators. These rolls are organized by operator and then alphabetically by lease name. It should be noted that there are very few unit cards for major companies and that, if any information was filed on a lease or well, it will be found on this set of film. It should also be noted that major operators, even in the early years of the oil business, were very prudent about filing completions and plugs for wells which they operated.

**Well Records-Old Warehouse Film**

This set of film contains some of the earliest information filed with the Texas Railroad Commission and includes oil and gas well records filed from 1919 to 1939. There are only five rolls of this film, with three rolls organized numerically by operator number and two rolls organized alphabetically by operator name.

**Well Records - K, L, and M Film**

In March, 1966, the Texas Railroad Commission instituted a new filing system. However, before the system could be fully implemented, many well records which were filed during the period of transition were placed onto the K, L, and M film. The K Run covers portions of records filed from 1963 to 1964, the L Run covers portions of records filed from 1964 to 1965, and the M Run covers portions of records filed from 1965 to

March 1966. The K, L, and M film is organized by operator number, with leases listed alphabetically within operator number.

### **Potential Film**

In March of 1966, the Texas Railroad Commission filing system was converted to the potential filing system, which is currently used. This film contains records of all wells that produced oil and/or gas and were placed in a designated oil or gas field. This film is organized by Texas Railroad Commission District, field name, and oil lease number or gas well identification number.

### **Wildcat and Suspense Film**

This film contains records of all wells with applications to drill in wildcat fields or new leases in designated fields that were on leases that did not have a lease identification number previously assigned due to no producing wells on the lease in the field. This film is organized by district, county, and/or American Petroleum Institute (API) number. The API number system has been in effect since April 1966. The numbers have been stored within the Texas Railroad Commission computer system as well as being noted on all forms filed for the well. The system allows information to be retrieved by computer showing drilling status, operator, lease name, oil lease number or gas identification number, and field name. This is a very efficient system and allows quick and accurate retrieval of data filed since 1978.

### **Well Record Files**

These are the hard copy files of data not yet placed on microfilm. These files are organized by district, field name, and oil lease number or gas identification number. These files contain the most recent data processed by the Central Records staff of the Texas Railroad Commission. Inside these folders are references to data that have been placed onto potential film.

### **Suspense Files**

These files contain the most recent information to be filed with the Central Records Department. This is the holding area for information to be placed into existing well record files or to have new oil lease or gas identification files prepared. The information is filed by district and API number. To obtain API numbers assigned to these records, it is

necessary to search suspense cards that are filed by district, county, and alphabetically by lease name. Records that have not been placed in suspense files are usually found within the Map where they are held until data is placed on to the county oil and gas base maps or on field maps.

The aforementioned record sets are the primary file systems utilized to access records in the Texas Railroad Commission. In retrieving information from the Texas Railroad Commission, the researcher often has to examine every file system available in search of a particular piece of information.

#### **VIII.B.2.1.4 Research Procedures for Geophysical Well Logs and Scout Tickets**

A commercial log library (Cambe) was contacted for information concerning the wells within the Area of Review. These libraries maintain extensive geophysical well log collections as well as scout ticket files. Scout tickets are especially useful as they often contain information not routinely listed on the state forms (such as testing data, core information, formation tops, alternate operator names, etc.). Scout tickets and geophysical well logs were requested for all of the artificial penetrations within the Area of Review.

### **VIII.B.3 Artificial Penetration Evaluation**

After compiling the information from the various data sources, a critical review of each artificial penetration was undertaken. All artificial penetration records were examined to identify improperly constructed and/or plugged wells, along with other disposal operations which may exist in the Area of Review. Once identified, the artificial penetrations were then subdivided into wells that are abandoned and wells that are active. Well evaluation considered current status, Confining Zone/Injection Zone Penetration, nature of the strata penetrated and drilling methods.

#### **VIII.B.3.1 Well Status**

Each artificial penetration (active/abandoned) was evaluated as to the adequacy of construction and plugging to determine the potential of the penetration to convey fluid from an injection zone into the overlying USDWs (non-endangerment) and the potential of the penetration to convey injected effluent out of the injection zone (no migration). Potential problem wells were identified and were subsequently evaluated or modeled to determine the need for corrective action.

### **VIII.B.3.2 Confining/Injection Zone Penetration**

Wells that penetrate the confining and/or injection zone may have the potential for conveying fluid from the injection zone to an overlying formation or from the injection zone to an overlying USDW. Available geophysical well logs from the artificial penetrations within the Area of Review were correlated to determine which of the wells penetrate the confining/injection zone. Wells that do not penetrate this interval do not provide potential avenues for fluid movement and need not be evaluated further.

### **VIII.C Tabulation of Artificial Penetrations in the Area of Review**

A tabulation of data on all of the artificial penetrations within the 2.5-mile radius Area of Review are included in Table VIII-1. This data includes: permit application identification number; operator information; well lease name; total depth and field name.

### **VIII.D Schematics and Records for Artificial Penetrations in the Area of Review**

Schematics and records data (state forms and scout tickets) for all of the artificial penetrations within the 2.5-mile radius Area of Review are included in Appendix 4. Information included on the well schematics are: permit application identification number; operator information; well lease name; status; casing information; key hydrologic and geologic datums; and cement plugging depths.

### **VIII.E Improperly Constructed or Abandoned Artificial Penetrations**

For purposes of evaluating artificial penetrations, the Statewide Rules For Oil, Gas and Geothermal Operations (1986), from the State of Texas was used to determine proper plugging requirements for the protocol, as the rules are very specific and stringent. The Texas Railroad Commission, under Statewide Rule 14, (1967), demands all formations bearing USDWs, oil, gas or geothermal resources be protected with type-specific cement plugs and mud-laden fluid. Uncemented areas in the abandoned wellbore must be filled with a mud-laden fluid weighing at least 9.5 lb./gal (Railroad Commission of Texas, 1986). Setting depths for cement plugs are dependent upon the construction of the well and the geological environment.

#### **VIII.E.1 Incomplete Records**

Most of the wells in the AOR were drilled in the 1930's and 40's and as such have very poor well records if they exist at all. Wells that were identified as having been drilled but missing the necessary records to document adequacy of plugging and/or construction, were considered

potential problem wells and evaluated or modeled for possible vertical fluid movement utilizing the known data.

### **VIII.E.2 Modeling Improperly Constructed or Improperly Plugged Wells**

Within the 2.5-mile radius Area of Review there are a large number of wells identified as either improperly constructed or improperly plugged using the non endangerment criteria outlined above. These improperly constructed or improperly plugged wells are in communication with the Upper Cockfield sand and were modeled by comparing the conservatively predicted pressure increases from the BOAST Pressure Model at the end of 30 years of injection with the calculated allowable pressure buildup (static column pressure plus minimum gel strength) at the top of the respective injection interval formation, using well specific information (mud weight, borehole diameter, formation depth, etc.). In cases where information was not available, conservative assumptions were made in the model calculations. These assumptions are summarized below:

- a) For purposes of calculating the pressure due to gel strength, in cases where the borehole diameter across the injection interval sands was unknown, the surface casing diameter was used as the bit size. This is conservative since the actual bit diameter must be less than the outer diameter of the surface casing string.
- b) For purposes of calculating the pressure due to gel strength, conservative gel strength of 40 lb/100 sq. ft. was used. This is conservative as studies indicate that with time, the gel strength of mud may be more than an order of magnitude higher (Pierce, 1989). Additionally, in order to be conservative in the calculation, one inch was added to the bit diameter to account for potential borehole washout.
- c) For purposes of calculating the static mud column pressure, in cases where the weight of the mud in contact with the injection intervals could not be found, a very conservative drilling mud weight of 9.0 lb./gal was used. This is conservative since the available drilling information from area well logs indicates that the mud weight was always higher than 9.0 lb./gal.
- d) In order to be extremely conservative in calculating the static column pressure, a fallback of 50 feet in the mud column was assumed in the calculations. This is very conservative as state regulations require that all uncemented intervals in a well be filled with mud. Additionally, mud to surface is required to support the surface plug, otherwise, the plug would not set properly and would fall down the hole.

The calculations used in the modeling analysis are discussed in Section VII.F.2 of this application. These calculations indicate that the maximum allowable pressure increase allowable



of 478 psi. There are three wells located within 150 feet of the injection well. The pressure increase at 150 feet predicted by the model at the end of 30 years is 456 psi. . Each of the wells was completed in the Upper Cockfield production zone at approximately 5,200 feet. None of the wells penetrate into the Middle or Lower Cockfield formation.

Since the injection zone includes the entire Cockfield formation due to the potential for communication between the three layers of the formation, these wells technically penetrate the injection zone. In reality, the wells are completed more than 800 feet above the Lower Cockfield injection zone and the additional pressure required for injection to force fluids through the formation to the boreholes is significant. The vertical pressure required to lift fluid through the shale sand sequences would be higher than the pressure available in the injection zone. In addition, the permeability of the Middle and Upper portions of the Cockfield formation is higher than the Lower Cockfield and would act as a pressure sink which would lower the pressure buildup in the well area.

Since all of the wells pass the evaluation demonstration, no corrective action is required for any of the artificial penetrations located in the Area of Review.

#### **VIII.F Corrective Action Plan for Improperly Constructed or Abandoned Artificial Penetrations**

No improperly constructed or improperly plugged wells fail the conservative modeling evaluation. Therefore, corrective action program is not warranted, as all of the artificial penetrations are either properly constructed, plugged or abandoned, or have a sufficient hydrostatic column so as to prevent the movement of fluids into or between USDWs.

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